



Prioritized Technology: Ice Sample Return Responsive Systems for Containment

Technical Goal

Actively monitor and maintain containment of samples with minimal degradation in relevant Ocean World environments from sample collection through Earth entry and return and under hermetic sealing conditions.

Near Term: Development of Hardware: Breadboard containers with capacity to trap and contain evolved gases, maintaining a constant seal under changing ambient temperatures and pressures

Mid Term: - Monitoring Systems : Develop techniques for monitoring of containment variables (Temp, Pressure, leak rate) from time of sealing through return.

Long-Term: Active Control Systems : Maintain sample temperature via active power regulation & novel passive insulation methods (*may be cryogenic or non-cryogenic, depending on target body*)

Technical Status

- **Low TRL (<2):** Temperature regulation technologies, whether by active or passive control, are needed to minimize thermal impact of transport from an Outer Planets body to Earth.
- **Hermetic Sealing Status:** NASA has previously funded SBIR I/II work to develop hermetic sealing of metal canisters via brazing. Technology to develop sealing under thermal conditions that may result in melting or sublimation are needed. Trapping and containment of evolved gases/over pressure relief need development as well as low-power consumption T monitoring.
- **Thermal Control Status:** NASA has funded concept studies over the years. Hardware technology development for thermal insulation designs, passive/active cooling (power levels consistent with current and potential power allocations)

Mission Applications

What is enabled if we achieve the goal?

Both Science and PP

Reduced Risk to Samples: Controlled and monitored environments allow for accurate modeling of degradation of biosignatures and loss and evolution of volatiles during the return process.

Backward Contamination Risk Reduction for:

- Europa: Clipper, Lander, Sample Return
- Enceladus: Plume Sample Return, Lander Sample Return

Reduced Uncertainty: Maintenance and collection of data associated with containment hardware provides solid inputs to Earth Safety Analysis, reducing risk for Restricted Earth Return missions which may undergo non-NASA regulatory tests/measurements prior to release from containment.

Development Cost and Schedule